Original Article

Effect of Yoga on migraine: A comprehensive study using clinical profile and cardiac autonomic functions

Ravikiran Kisan, Sujan MU[1], Meghana Adoor[1], Raghavendra Rao[2], Nalini A[3], Bindu M Kutty[1], Chindanda Murthy BT[4], Raju TR[1], Sathyaprabha TN[1]

Department of Physiology, SS Institute of Medical Sciences and Research Centre, Davangere, [1]Departments of Neurophysiology, and [3]Neurology, National Institute of Mental Health and Neuro Sciences, [2]Department of CAM, Senior Scientist and Head, Bangalore Institute of Oncology, Health Care Global Ent, [4]Department of Natural Medicine, Jindal Pg Institute Of Naturopathy and Yogic Sciences, Bengaluru, Karnataka, India

Address for correspondence: Dr. Sathyaprabha TN, Department of Neurophysiology, National Institute of Mental Health and Neurosciences, Bengaluru, Karnataka, India. E-mail: drsathyaprabha@gmail.com

ABSTRACT

Context and Aims: Migraine is an episodic disabling headache requiring long-term management. Migraine management through Yoga therapy would reduce the medication cost with positive health benefits. Yoga has shown to improve the quality of life, reduce the episode of headache and medication. The aim of the present study was to evaluate the efficacy of Yoga as an adjuvant therapy in migraine patients by assessing clinical outcome and autonomic functions tests.

Subjects and Methods: Migraine patients were randomly given either conventional care (*n* = 30) or Yoga with conventional care (*n* = 30). Yoga group received Yoga practice session for 5 days a week for 6 weeks along with conventional care. Clinical assessment (frequency, intensity of headache and headache impact) and autonomic function test were done at baseline and at the end of the intervention.

Results: Yoga with conventional care and convention care groups showed significant improvement in clinical variables, but it was better with Yoga therapy. Improvement in the vagal tone along with reduced sympathetic activity was observed in patients with migraine receiving Yoga as adjuvant therapy.

Conclusions: Intervention showed significant clinical improvement in both groups. Headache frequency and intensity were reduced more in Yoga with conventional care than the conventional care group alone. Furthermore, Yoga therapy enhanced the vagal tone and decreased the sympathetic drive, hence improving the cardiac autonomic balance. Thus, Yoga therapy can be effectively incorporated as an adjuvant therapy in migraine patients.

Key words: Autonomic functions; conventional care; migraine; Yoga

INTRODUCTION

Migraine clinically manifests as hemi-cranial throbbing type of pain associated with nausea, vomiting, heightened sensitivity to light (photophobia) and sound (phonophobia) with or without transient neurological symptoms.[1] Migraine is one of the common primary headache disorders affecting 13% of the population world-wide.[2] Prodromal, headache episode and postdromal phases of migraine are known to impact productivity at work and quality of life, apart from causing cognitive impairment.[3] The burden of migraine impacts affected individuals, their family, and society.[4,5] It is also a risk factor for ischemic cerebral and ischemic cardiovascular diseases.[6] Episodic migraine may lead to chronic migraine, if it is not treated properly it may lead to medication overuse headache and increased risk of suicidal attempt.[7]

Access this article online	
Website: www.ijoy.org.in	Quick Response Code
DOI: 10.4103/0973-6131.133891	

Autonomic nervous system (ANS) imbalance explains many of the clinical manifestations of the migraine disorder. Autonomic symptoms (such as nausea, vomiting, or diarrhoea, cutaneous vasoconstriction [pallor], vasodilatation [flushing], piloerection and diaphoresis) are common during acute migraine headaches.[8]

Migraine is a chronic disorder with episodic disabilities and it requires long-term management as well as

preventive strategies. The treatment of migraine involves both acute and preventive drugs along with non-pharmacological strategies. Even though in the last few decades much advancement has occurred in the research field of migraine, its treatment does not provide complete relief to many patients. Biofeedback and relaxation have been demonstrated to be useful alternatives to standard medical therapy for both migraine and tension-type headaches.[9] The present study was aimed to evaluate the effect of Yoga as adjuvant therapy in patients with migraine.

SUBJECTS AND METHODS

The present study was approved by the Institutional Ethical Committee. Sixty patients were recruited from a tertiary referral neurology centre. Diagnosis of migraine, with or without aura was done according to the guidelines of International Headache Society, International Classification of Headache Disorders 2nd edition (IHS, ICHD – II)[1] after thorough clinical interview, physical and neurological examination by the neurologist. Both male and female migraine patients between the age group of 15-60 years satisfying the IHS, ICHD – II criteria for migraine without (1.1) or with aura (1.2.1) with a history of at least 2 years of migraine and headache frequency of 5-15/month were recruited for the study. Patients with other medical or neurological illness were not included in the study. Recent head or neck traumas within 2 years were excluded from study. Furthermore female patients who were pregnant or lactating were not recruited for the study. Recruited patients were explained about the nature of study and written informed consent was obtained. Patients were randomized mainly to conventional care only (CC) and conventional care and Yoga therapy (Y) using a concealed allocation protocol. [Study design – Figure 1]

Group (CC)

Migraine patients received conventional care for 6 weeks. Patients were advised to maintain headache diary for this period. 1 week after baseline assessment, confirmation of maintaining headache diary was done by telephonic conversation or personal contact. At the end of 6 week post-intervention, assessment was done and headache diary was collected.

Group (Y)

Migraine patients receiving conventional care and Yoga therapy had received Yoga therapy along with conventional care. Patients were scheduled to visit for 30 sessions (5 days a week for 6 weeks) of Yoga. They were asked to maintain headache diary for the full duration of the study and was verified during Yoga session. At the end of 6 weeks, post-intervention assessment was done and headache diary was collected. The Yoga intervention

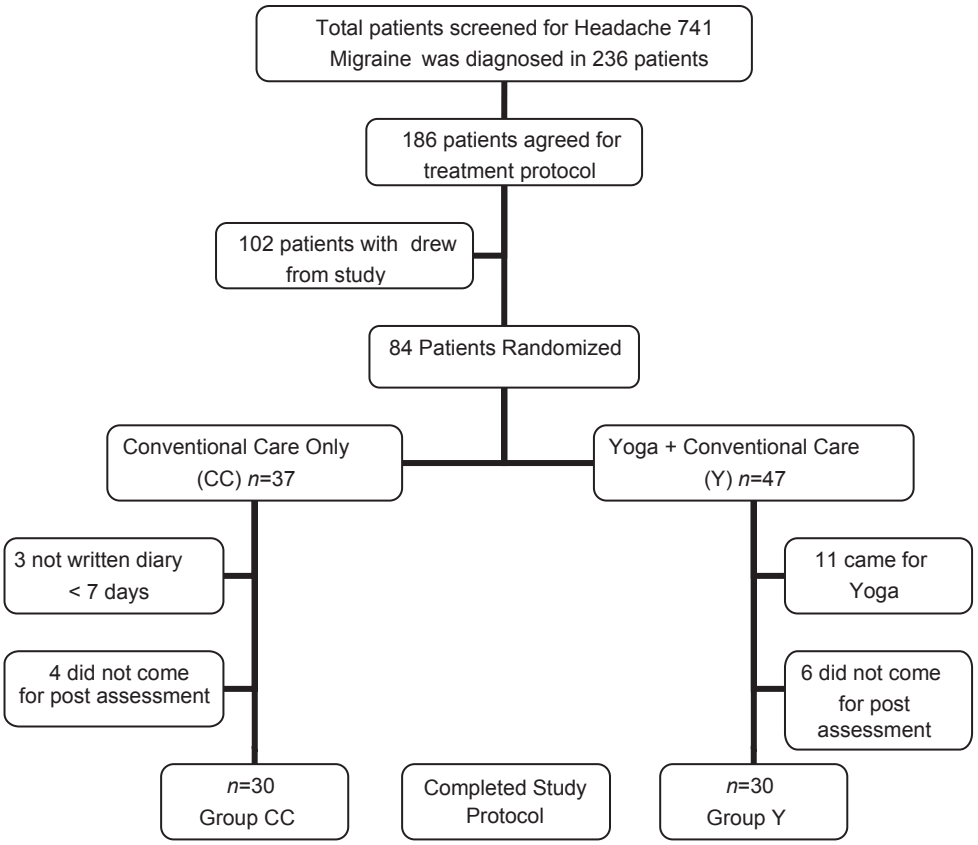

Figure 1: Study design. CC-Conventional care group, Y-Yoga+Conventional care group

consisted of a daily practice of loosening exercises, breathing exercises, asanas or postures done with awareness and Shavasana [Table 1]. Each Yoga session lasted about an hour. Yoga therapy was imparted by a trained Yoga therapist at the Yoga centre in the institution's premises. Daily record of attendance and compliance to Yoga intervention were maintained.

The subjective variable, headache-specific quality of life was measured as the change in headache-related disability, which was assessed by the headache impact test (HIT-6). The total number of headache episodes, intensity of headaches (0-10 on Visual analog scale) and medication used were noted in headache diary by patients. Self-perceived benefit of the intervention was measured at the end of the 6th week of the treatment period in both groups. Patients rated the perceived benefit of the therapy on a five point scale ranging from "greatly worsened my clinical condition" to "greatly improved my clinical condition." In addition, they assessed the therapy as "more harmful than helpful," "neither harmful nor helpful," or "more helpful than harmful."

Autonomic function test was done when the subject was headache-free at least 3 days before and after the test. Autonomic function tests were carried out in autonomic laboratory, under all standardized conditions.[10-12] Lead II electrocardiogram (ECG) and breathing signals were conveyed through analog digital converter (Power lab, 16 channels data acquisition system, AD Instruments, Australia) with a sampling rate of 1024 Hz. The data were stored and were analyzed offline using an automatic programme that allowed visual checking of the raw ECG and breathing signals. 15 min basal recordings were stored and later analyzed to obtain both time and frequency domain parameters of heart rate variability (HRV) using HRV Analysis Software V1.1 (Power lab 16 channels data Acquisition System, AD instrument, Australia). HRV recording and analysis were performed according to the guidelines of Task force report.[13] An artefact free 5 min segment was analyzed to obtain time domain (Heart rate, standard deviation (SD) of NN interval, square root of the mean of the sum of squares of differences between adjacent R-R intervals) and frequency domain (Total power, low frequency power [LF power], low frequency normalized units, high frequency power [HF power], high frequency normalized units [HFnu], sympathovagal balance [SVB] – LF/HF ratio) parameters of HRV.

Statistical analyses were carried out on statistical package for the social sciences 15.0 software supplied by IBM. Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements were presented on Mean ± SD unpaired *t*-test was used to compare the variables at the baseline characteristics of the two groups of patients. Paired *t*-test was used to compare the clinical, HRV, following 6 week intervention. HRV parameters were square root transformed for analysis and presented after back transforming. Level of significance was kept at 0.05.

RESULTS

A total of 30 migraine patients were studied under conventional care (Group CC) and 30 patients were studied under Yoga with conventional care (Group Y) group. Both the study groups were identical in demographic variables such as age, gender distribution, height and weight. No significant differences in mean duration of the illness, frequency and intensity were observed among the two groups [Table 2].

HIT score was found significantly enhanced in group CC (75.43 ± 0.88) compared to group Y 66.60 ± 3.21). No significant difference was observed in the baseline HRV parameters between two groups. Headache frequency, intensity and HIT scores were reduced in both groups of migraine patients [Table 3].

Significant reductions in monthly headache frequency, average pain intensity, and headache-related disability were seen in both the Yoga and CC care groups. However, the group Y showed improvements in all clinical outcome measures to a greater extent [Tables 4 and 5]. Significant

Table 1: Yoga module for migraine patients

Practices
Sookshma Vyayama (loosening exercises) (daily)
Fingers, wrist, elbows, shoulder rotation
Neck flexion/extension
Neck rotation
Padasanchalana
Hand stretch breathing
Sashankasana breathing
Shavasana with breath awareness
Yogasanas (daily)
Suryanamaskar-2 rounds
Padahasthasana, Ardha chakrasana, Trikonasana, Bhujangasana, Vakrasana, Ustrasana
Shavasana-Yoga Nidra or deep relaxation technique

Table 2: Comparison of demographic and clinical details of patients

Variables	Group CC (*n*=30)	Group Y (*n*=30)	*P* value
Age in years	31.27±8.63	31.72±10.77	0.858
Gender M: F	11:19	9:21	0.584
Height (cm)	166.12±2.12	168.61±1.61	0.263
Weight (kg)	65.68±2.46	67.20±2.59	0.945
MA: MOA	7:23	4:26	0.317
Duration of illness (years)	10.53±6.34	12.67±8.49	0.275
Frequency of headache/month	10.47±3.75	11.30±5.05	0.471
Intensity of headache	9.30±1.15	8.70±1.26	0.059

M=Male; F=Female; MA=Migraine with aura; MOA=Migraine without aura

reduction in the frequency of headache observed in the group Y compared to group CC Even the intensity of headache also reduced significantly in both groups, which was assessed by visual analogue scale ('0' being no pain and '10' being the worst pain). At baseline headache intensity was 9.30 ± 1.15 and 8.70 ± 1.26 in Group CC and Group Y respectively. After the end of 6 weeks intervention migraine patients reported headache intensity as 7.73 ± 1.23 in group CC and 2.03 ± 1.29 in group Y. The group Y has shown significant reduction in heart rate ($P < 0.05$) compared to group CC. Group Y has shown more reduction in LF nu and SVB than group CC after the intervention but both group have shown statistically significant changes. Group Y has shown statistically significant increased HF power and HFnu [Table 6].

DISCUSSION

In the present study, migraine patients had very severe impact on their life (HIT score more than 60) at baseline in both the groups. After 6 weeks of intervention, both group showed statistically significant reduction of HIT score. But only Yoga with conventional care group has shown headache has little to no impact on patient's life.

The self-perceived benefit of the intervention was measured at the end of the 6-week treatment period. The patients rated the perceived benefit of the therapy on a five point scale ranging from "greatly worsened my clinical condition" to "greatly improve my clinical condition." Migraine patients reported that intervention improved their clinical condition except 13.3% patients with conventional care only reported as neutral. In addition, patients assessed the therapy as "more harmful than helpful", "neither harmful nor helpful," or "more helpful than harmful." All patients in Yoga with conventional care and 73.3% of conventional care patients told that therapy was more helpful than harmful. This infers that Yoga intervention with conventional care has better patient's improvement and in turn acceptances, than the conventional care only, without any adverse effects.

Table 3: Effect of treatment on clinical variables

Group	Pre	Post	Pre versus post *P* value
Headache frequency (per/month)			
Group CC	10.5±3.8	5.2±2.1	<0.001***
Group Y	11.3±5.1	1.8±1.5	<0.001***
Group CC versus group Y *P* value	0.471	<0.001***	-
Headache intensity			
Group CC	9.30±1.2	7.73±1.2	<0.001***
Group Y	8.70±1.3	2.03±1.3	<0.001***
Group CC versus group Y *P* value	0.059	<0.001***	-
HIT score			
Group CC	75.4±0.9	68.6±4.6	<0.001***
Group Y	66.6±3.2	38.9±2.2	<0.001***
Group CC versus group Y *P* value	0.010*	<0.001***	-

HIT=Headache impact test; *P<0.05 Significant, **P<0.01 Very significant, ***P<0.001 Very very significant

The time domain HRV parameters in Yoga with conventional care has shown significant increase in mean R-R interval and reduced heart rate compared to conventional care group at the end of 6 weeks intervention. This denotes an improved vagal tone after Yoga intervention. In frequency domain parameters HF power was increased and LF power was reduced with reduced SVB (LH/HF ratio) reflecting increased parasympathetic and reduced sympathetic tone in patient with Yoga intervention. Low frequency and SVB (LF/HF ratio) were reduced in conventional care group. Considering all HRV parameters, Yoga with conventional care has shown reduction in sympathetic tone as well as increased vagal tone. However in case of conventional care only reduction in sympathetic tone was noted, without much alteration in the vagal tone. Therefore, increasing vagal tone by Yoga intervention may improve cardiovascular health and outcomes.

Along with this the study has demonstrated that migraine patients improved clinically in both groups following 6 weeks of intervention. Reduction in the frequency and intensity was more in the Yoga with conventional care group. Clinical benefits, self-perceived health benefits and improvement in vagal tone with reduced sympathetic tone were found in Yoga with conventional care group.

For migraine treatment, regular exercise is frequently recommended. Many of the studies have reported beneficial effects of aerobic exercise on both frequency and intensity of migraine as well as on the duration of the attacks and on patient's well-being.[14,15] Reduction in pain, stress and anxiety perception in exercising persons may be due to modification in beta endorphin and hormonal secretion levels.[16,17]

Table 4: Comparison of self-perceived benefits of the intervention in two groups of migraine patients

Group	Greatly worsened my clinical condition (0)	(1)	(2)	(3)	Greatly improved my clinical condition (4)
Group CC (*n*=30) (%)	0 (0)	0 (0)	4 (13.3)	17 (56.7)	9 (30)
Group Y (*n*=30) (%)	0 (0)	0 (0)	0 (0)	1 (3.3)	29 (96.7)

Table 5: Comparison of the assessment of therapy by two groups of migraine patients

Group	More harmful than helpful	Neither harmful nor helpful	More helpful than harmful
Group CC (*n*=30) (%)	0 (0)	8 (26.7)	22 (73.3)
Group Y (*n*=30) (%)	0 (0)	0 (0)	30 (100)

However, around 22% of migraine patients complain as exercise was a trigger factor and hence some patients avoid exercise and were physically less active.[18,19] In Yoga, slower movements or even static muscular exercises are done with mindfulness and during the activities; person has to think what they are doing during the act. They also have to feel the movements and develop awareness of body and body motion.[20] Hence Yoga, a slow non-exertional aerobic exercise is more beneficial than pure aerobic exercise. Studies have shown that Yoga – type of mindful slow exercise is better than aerobic exercise or non-aerobic mindful exercise in enhancing mood and alleviating stress and depression.[17]

Yoga has been effective in numerous chronic diseases such as asthma, diabetes, arthritis, fibromyalgia, depression, ischemic heart disease etc., where stress is believed to play an important role.[21] Yoga is shown improvement quality of life, reduce the episodes of headache attack and medication score in chronic tension type headache and migraine.[22,23]

ANS is involved in control of homeostasis as the body's response to this stress and same stress can be a trigger for migraine. One of the main pain relieving factors in migraine patients is sleep and the sympathetic system drive decreases during sleep. On the other hand, relaxation techniques decrease sympathetic system drive, causing a partial relief in migraine headaches. Hence, ANS modulation either by pharmacotherapy or non-pharmacotherapy improves the symptoms.

Yoga has shown to reduce stress arousal patterns, reduce stress hormones such as cortisol[24] and bring stable autonomic balance in health[25] and diseases.[26,27] The mechanism by which Yoga practices bring the changes in ANS can be explained by the following two hypotheses - In one hypothesis, exercise training improves vagal modulation through angiotensin II and nitric oxide (NO). The mechanism of increased vagal tone by exercise may be due to reduction of angiotensin II. Angiotensin II is known to inhibit cardiac vagal activity.[28] Exercise training suppresses Angiotensin II expression.[29] Studies have shown plasma renin activity levels were lower in athletes than in untrained individuals or non-athletes and sedentary individuals. These findings were suggest that athletes with lower plasma renin activity would have lower angiotensin II and higher associated levels of cardiac vagal activity. NO may also play a role in increasing cardiac vagal control and may indirectly inhibit sympathetic influences.[30] Exercise training has been found to improve endothelial function and NO bioavailability, hence indirectly reduces sympathetic activity.[31,32] In another hypothesis, voluntary slow deep

Table 6: Effect of treatment on HRV parameters in two groups of patients

HRV	Pre	Post	Pre versus post *P* value
Time domain HRV parameters			
Heart rate (bpm)			
Group CC	72.7±1.7	73.6±2.2	0.663
Group Y	76.8±2.3	73.3±1.8	0.043*
Group CC versus group Y *P* value	0.159	0.911	-
SDNN (ms)			
Group CC	52.2±0.7	52.92±0.1	0.864
Group Y	44.0±0.1	48.32±0.1	0.259
Group CC versus group Y *P* value	0.217	0.480	-
RMSSD (ms)			
Group CC	41.9±0.2	42.21±0.2	0.941
Group Y	29.8±0.1	35.91±0.1	0.142
Group CC versus group Y *P* value	0.075	0.366	-
Frequency domain HRV parameters			
TP (ms^2)			
Group CC	2997.9±39.7	3085.1±32.7	0.856
Group Y	1898.3±11.7	2538.8±11.6	0.110
Group CC versus group Y *P* value	0.125	0.442	-
LF (ms^2)			
Group CC	724.8±11.3	666.0±8.0	0.703
Group Y	505.9±3.0	476.5±1.9	0.698
Group CC versus group Y *P* value	0.246	0.211	-
LF (nu)			
Group CC	48.0±0.1	44.0±0.1	0.033*
Group Y	56.3±0.0	43.1±0.1	<0.001***
Group CC versus group Y *P* value	0.070	0.841	-
HF (ms^2)			
Group CC	792.3±15.3	813.6±14.1	0.900
Group Y	374.7±5.2	608.6±5.7	0.042*
Group CC versus group Y *P* value	0.057	0.390	-
HF (nu)			
Group CC	41.8±0.1	43.0±0.1	0.578
Group Y	34.8±0.1	46.6±0.1	<0.001***
Group CC versus Group Y *P* value	0.100	0.391	-
SVB			
Group CC	1.9±0.1	1.51±0.1	0.002**
Group Y	2.0±0.1	1.1±0.1	<0.001***
Group CC versus Group Y *P* value	0.826	0.140	-

HRV=Heart rate variability; bpm=Beats/minute; SDNN=Standard deviation of NN intervals (ms); RMSSD=Square root of the mean of the sum of squares of differences between adjacent R-R intervals (ms); HF=High frequency; TP=Total power; LF=Low frequency; SVB=Sympathovagal balance, *P<0.05 Significant, **P<0.01 Very significant, ***P<0.001 Very very significant

breathing and exercises reset the ANS through stretch induced inhibitory signals and hyperpolarization currents propagated through both neural and non-neural tissue which synchronizes neural elements in the heart, lungs, limbic system and cortex. During inspiration, stretching of lung tissue produces inhibitory signals by action of slowly adapting stretch receptors and hyperpolarization current by action of fibroblasts. Both inhibitory impulses and hyperpolarization current synchronize neural elements leading to the modulation of the nervous system and decreased metabolic activity i.e., parasympathetic state,[33] Human information processing during yogic exercises altered at cortical level in the hypothalamus and limbic system which in turn modulates the output of ANS, hypothalamo - pituitary axis and immune responses.[34,35]

Hence Yoga along with convention care has definite effect on migraine frequency and intensity, which were assessed by clinical scales and HRV analysis. Therefore it can reduce the dosage of drug in the conventional care and reduce the pharmacological adverse effects.

CONCLUSION

Significant clinical improvement was observed in both Yoga and Conventional care group with 6 weeks of intervention. Yoga therapy showed an additional beneficiary effect on patients with migraine by reducing frequency and intensity. Hence, Yoga therapy can be used as adjuvant therapy for migraine.

However, evaluation of autonomic parameters in patient with migraine before and after interventions was the novel one. Yoga therapy showed added benefit on autonomic modulation by improving the vagal tone. To conclude autonomic function tests can be used as prognostic indicator, in patient with migraine.

Limitations of the study

The study was not blinded and there was no sham group for Yoga therapy.

ACKNOWLEDGEMENT

Central Council for Research in Yoga and Naturopathy, Department of AYUSH, Ministry of Health and Family Welfare, Government of India, New Delhi.

REFERENCES

1. Headache Classification Subcommittee of the International Headache Society. The international classification of headache disorders: 2nd edition. Cephalalgia 2004;24 Suppl 1:9-160.
2. Lipton RB, Bigal ME. Migraine: Epidemiology, impact, and risk factors for progression. Headache 2005;45 Suppl 1:S3-13.
3. Merikangas KR, Cui L, Richardson AK, Isler H, Khoromi S, Nakamura E, *et al*. Magnitude, impact, and stability of primary headache subtypes: 30 year prospective Swiss cohort study. BMJ 2011;343:d5076.
4. Steiner TJ, Scher AI, Stewart WF, Kolodner K, Liberman J, Lipton RB. The prevalence and disability burden of adult migraine in England and their relationships to age, gender and ethnicity. Cephalalgia 2003;23:519-27.
5. Lipton RB, Bigal ME, Kolodner K, Stewart WF, Liberman JN, Steiner TJ. The family impact of migraine: Population-based studies in the USA and UK. Cephalalgia 2003;23:429-40.
6. Kurth T, Gaziano JM, Cook NR, Logroscino G, Diener HC, Buring JE. Migraine and risk of cardiovascular disease in women. JAMA 2006;296:283-91.
7. Breslau N, Schultz L, Lipton R, Peterson E, Welch KM. Migraine headaches and suicide attempt. Headache 2012;52:723-31.
8. Mosek A, Novak V, Opfer-Gehrking TL, Swanson JW, Low PA. Autonomic dysfunction in migraineurs. Headache 1999;39:108-17.
9. Rains JC, Penzien DB. Behavioral treatment strategies for migraine and tension-type headache: A review of the evidence and future directions. Expert Rev Neurother 2002;2:749-60.
10. Netz Y, Lidor R. Mood alterations in mindful versus aerobic exercise modes. J Psychol 2003 Sep;137:405-19.
11. Sathyaprabha TN, Satishchandra P, Netravathi K, Sinha S, Thennarasu K, Raju TR. Cardiac autonomic dysfunctions in chronic refractory epilepsy. Epilepsy Res 2006;72:49-56.
12. Udupa K, Sathyaprabha TN, Thirthalli J, Kishore KR, Lavekar GS, Raju TR, *et al*. Alteration of cardiac autonomic functions in patients with major depression: A study using heart rate variability measures. J Affect Disord 2007;100:137-41.
13. Abhishekh HA, Nisarga P, Kisan R, Meghana A, Chandran S, Trichur Raju, *et al*. Influence of age and gender on autonomic regulation of heart. J Clin Monit Comput 2013;27:259-64.
14. Heart rate variability. Standards of measurement, physiological interpretation, and clinical use. Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology. Eur Heart J 1996;17:354-81.
15. Lockett DM, Campbell JF. The effects of aerobic exercise on migraine. Headache 1992;32:50-4.
16. Varkey E, Cider A, Carlsson J, Linde M. Exercise as migraine prophylaxis: A randomized study using relaxation and topiramate as controls. Cephalalgia 2011;31:1428-38.
17. Darabaneanu S, Overath CH, Rubin D, Luthje S, Sye W, Niederberger U, *et al*. Aerobic exercise as a therapy option for migraine: A pilot study. Int J Sports Med 2011 Jun;32:455-60.
18. Long BC, Stavel RV. Effects of exercise training on anxiety: A meta-analysis. J Appl Sport Psychol 1995;7:167-89.
19. Petruzzello SJ, Landers DM, Hatfield BD, Kubitz KA, Salazar W. A meta-analysis on the anxiety-reducing effects of acute and chronic exercise. Outcomes and mechanisms. Sports Med 1991;11:143-82.
20. Kelman L. The triggers or precipitants of the acute migraine attack. Cephalalgia 2007;27:394-402.
21. Varkey E, Hagen K, Zwart JA, Linde M. Physical activity and headache: Results from the Nord-Trøndelag Health Study (HUNT). Cephalalgia 2008;28:1292-7.
22. Khalsa SB. Yoga as a therapeutic intervention: A bibliometric analysis of published research studies. Indian J Physiol Pharmacol 2004;48:269-85.
23. Bhatia R, Dureja GP, Tripathi M, Bhattacharjee M, Bijlani RL, Mathur R. Role of temporalis muscle over activity in chronic tension type headache: Effect of yoga based management. Indian J Physiol Pharmacol 2007;51:333-44.
24. John PJ, Sharma N, Sharma CM, Kankane A. Effectiveness of yoga therapy in the treatment of migraine without aura: A randomized controlled trial. Headache 2007;47:654-61.
25. Vedamurthachar A, Janakiramaiah N, Hegde JM, Shetty TK, Subbakrishna DK, Sureshbabu SV, *et al*. Antidepressant efficacy and hormonal effects of Sudarshana Kriya Yoga (SKY) in alcohol dependent individuals. J Affect

Disord 2006;94:249-53.
26. Telles S, Nagarathna R, Nagendra HR. Breathing through a particular nostril can alter metabolism and autonomic activities. Indian J Physiol Pharmacol 1994;38:133-7.
27. Sathyaprabha TN, Satishchandra P, Pradhan C, Sinha S, Kaveri B, Thennarasu K, *et al*. Modulation of cardiac autonomic balance with adjuvant yoga therapy in patients with refractory epilepsy. Epilepsy Behav 2008;12:245-52.
28. Sathyaprabha TN, Murthy H, Murthy BT. Efficacy of naturopathy and yoga in bronchial asthma: A self controlled matched scientific study. Indian J Physiol Pharmacol 2001;45:80-6.
29. Townend JN, al-Ani M, West JN, Littler WA, Coote JH. Modulation of cardiac autonomic control in humans by angiotensin II. Hypertension 1995;25:1270-5.
30. Buch AN, Coote JH, Townend JN. Mortality, cardiac vagal control and physical training – What's the link? Exp Physiol 2002;87:423-35.
31. Chowdhary S, Townend JN. Role of nitric oxide in the regulation of cardiovascular autonomic control. Clin Sci (Lond) 1999;97:5-17.
32. Kingwell BA. Nitric oxide as a metabolic regulator during exercise: Effects of training in health and disease. Clin Exp Pharmacol Physiol 2000;27:239-50.
33. Routledge FS, Campbell TS, McFetridge-Durdle JA, Bacon SL. Improvements in heart rate variability with exercise therapy. Can J Cardiol 2010;26:303-12.
34. Jerath R, Edry JW, Barnes VA, Jerath V. Physiology of long pranayamic breathing: Neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. Med Hypotheses 2006;67:566-71.
35. Kulkarni DD, Bera TK. Yogic exercises and health: A psycho-neuro immunological approach. Indian J Physiol Pharmacol 2009;53:3-15.

How to cite this article: Kisan R, Sujan MU, Adoor M, Rao R, Nalini A, Kutty BM, *et al*. Effect of Yoga on migraine: A comprehensive study using clinical profile and cardiac autonomic functions. Int J Yoga 2014;7:126-32.

Source of Support: Central Council for Research in Yoga and Naturopathy, Department of AYUSH, Ministry of Health and Family Welfare, Government of India, New Delhi, **Conflict of Interest:** None declared